

CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: January 5, 1956

Released: January 9, 1956

NORTHWEST AIRLINES, INC., BOEING 377, N 74601,
CHICAGO, ILLINOIS, AUGUST 5, 1955

The Accident

A Boeing 377, N 74601, owned by Northwest Airlines, Inc., and operated as Flight 410, went through the airport boundary fence beyond the far end of runway 31L after landing on that runway at Chicago Midway Airport, on August 5, 1955, at 1301.1/ No injuries were incurred by the passengers or crew. The aircraft was substantially damaged.

History of the Flight

Flight 410 originated at Minneapolis, Minnesota, with its destination Chicago, Illinois. Departure was from Minneapolis-St. Paul International Airport at 1130 on an IFR (Instrument Flight Rules) flight plan which designated a flight to be made via Victor Airway 25, Victor Airway 97, and Red Airway 28, at a cruising altitude of 15,000 feet. The crew consisted of Captain George A. Stone, First Officer Ralph T. Gray, Flight Engineer Harry L. Camm, Flight Engineer E. S. Lunde (deadheading), Stewardesses Helen L. Kennedy and Louise Holden, and Flight Service Attendants Michael D. Leahy and Earl Williams. There were 60 passengers on board.

According to company records the gross weight of the aircraft at the time of takeoff was 116,760 pounds and the load was properly distributed. The maximum operational takeoff gross weight was 120,770 pounds.

When the flight reported over Janesville, Wisconsin, an ARTC (Air Route Traffic Center) clearance was received to descend and cross the Wilson Intersection (15 miles NNW of Chicago Midway) at 3,500 feet. The IFR clearance was canceled by the pilot shortly after passing Wilson Intersection. At 1256 radio frequency was changed to Midway tower and the flight was then advised to report west of the field for a left turn for landing on runway 31L. Flight 410 was number three to land in a sequence pattern of five aircraft. Touchdown was about one-quarter down the runway, and the landing roll continued to the end of the runway without appreciable deceleration. At the end of the runway a slight turn to the left was made and the aircraft crossed several hundred feet of grassy area before crashing through the chain link fence bordering the airport. The aircraft stopped upright, heading west, with its main landing gear on the pavement of Central Avenue, the street bordering the west side of the airport. Passengers and crew left the aircraft via the emergency evacuation chute at the main cabin door and also through the exit door of the lower lounge compartment.

1/ All times herein are central standard and are based on the 24-hour clock; all altitudes are mean sea level.

Chicago Midway Airport weather at the time of the accident was: Ceiling 10,000 feet, broken clouds, overcast at 25,000 feet; visibility 10 miles; wind west 8 knots. During the period 1000 to 1300 there had been intermittent light rain showers (.01 inch); however, the runway surface was dry at the time Flight 410 landed.

Investigation

It was determined, from the observations of competent eyewitnesses and statements of the crew, that a touchdown had been made in the intersection of runways 31L and 36R. This location is approximately 1,600 feet beyond the approach end of runway 31L, which is 6,410 feet long. The first discernible braking marks of N 74601 on the runway were approximately 3,000 feet beyond the point of touchdown. These marks were light in character and extended on the runway for approximately 600 feet. The next 800 feet of marks reflected light to fair braking action, and the final 300 feet of marks at the end of runway 31L indicated heavy braking action, as did the marks across the 300 feet of grassy area leading to the boundary fence.

The substance of crew testimony is that airspeed at touchdown was approximately 95 knots. Following touchdown brakes were applied lightly. When the throttles were moved into the reverse quadrant forward thrust was experienced. When this occurred the captain put the throttles into the forward idle position, called for antiskid (a device designed to prevent locking of the wheels) off, and after getting no deceleration from use of the normal brakes used full and continuous application of the emergency system. The captain stated that he turned the aircraft to the left at the end of the runway to avoid striking the large concrete marker just off the end of runway 31L. All crew members stated there was no indication of propeller reversal at any time during the landing roll. This absence of the noise and deceleration accompanying propeller reversing is substantiated by many passengers and ground witnesses. Captain Stone testified that he felt there was sufficient runway remaining after the unsuccessful propeller reversal attempt to stop the aircraft with braking. He further stated he has had incidents at Midway Airport of slippery runways not due to snow, ice, or rain.

The surface of runway 31L is asphalt with a topping of crushed rock screenings. At the time of the accident the crushed rock covering was more in evidence near the ends than in the middle area of this much-used runway. When temperatures are above 90° F. the asphalt exudes an oily substance that creates a slippery surface. Temperature at the time of the accident was 85° F. and the runway was free of moisture. Although Midway tower had received no pilot reports of poor braking action on the day of the accident, controllers stated there had been instances of pilots reporting poor braking when temperatures were high and the runway was free of moisture.

The flight manual for B-377 aircraft indicates that with a gross load of 110,000 pounds (the approximate landing weight at Chicago of Flight 410), head wind of 8 knots, and temperature of 85 degrees, the aircraft should stop in 3,400 feet when landing over a 50-foot obstacle using normal braking, and without the use of propeller reversing. The minimum runway length under these conditions is 5,700 feet.

The aircraft received considerable structural damage. A majority of the blades of all four propellers were damaged by contact with the fence. The No. 3 engine mount was damaged to an extent requiring replacement of the powerplant. The four tires of the main gear indicated heavy braking action, as evidenced by large abraded areas extending almost through the casing. The wing flaps and the nose gear received damage from contact with the fence. The left side of the fuselage was sliced open from the top down to the "crease" line by the whirling of the steel fencing which became entangled in the propellers as the aircraft passed through the fence. The right side of the fuselage received lesser damage in the same manner. Contact with a street lighting pole indented the outer leading edge of the left wing.

Cockpit readings taken immediately after the accident revealed, among many other items, the following: Normal brake system pressure 1,500 p.s.i.; emergency brake system pressure 1,500 p.s.i.; antiskid master switch "off"; the reversing control "outboard and inboard" circuit breakers on the overhead panel in the "out" position. All other circuit breakers on this panel were "in."

The deadheading flight engineer, who had no assigned duties on the flight, was in the observer's seat behind the captain at the time of the landing. On his own initiative he pulled and immediately reset the oleo relay circuit breaker after the captain had tried unsuccessfully to obtain propeller reversing. The action of the "deadheading" flight engineer in pulling out and resetting the oleo relay circuit breaker after the one reversal attempt was an unrequested check on his part to ensure a good contact of this circuit breaker in the event that propeller reversal was again attempted. According to testimony of crew members, this was the only circuit breaker on the overhead panel moved during the entire flight.

The overhead panel is located in the forward part of the cockpit ceiling between and slightly to the rear of the two pilot seats, and immediately above and ahead of the flight engineer's seat. Dimensions of the panel are approximately 36 inches fore and aft and 18 inches wide. The forward half contains the engine ignition switches, feathering buttons, various engine operation and aircraft lighting switches. The rear half of the panel has five spanwise rows of approximately 25 circuit breakers each. The oleo relay circuit breaker is located in the rear row eighth from the left side and the two reversing control circuit breakers are located in the fourth row, from the rear, at the approximate center of the row. The two antiskid circuit breakers are immediately aft of the propeller reversing control circuit breakers. All circuit breakers can be reached from any of the three crew seats.

Following the accident the aircraft was removed to a hangar on Midway Airport. Structural repairs were made and No. 3 powerplant was replaced before actual testing of the braking and propeller reversing systems. On August 19 functional tests of these units were performed at Midway Airport. A preliminary ground runup included the following checks: Magneto, propeller reversing, and manual feathering. No discrepancies were noted and the aircraft was then turned over to the flight test crew. After taxiing, in which there were several effective applications of emergency brakes, a thorough engine runup was made. During this runup a check was made of auto-feathering, manual feathering, and propeller reversing with normal results.

The two reversing control circuit breakers were then pulled and a check was made of engine r. p. m. in the forward idle and reverse idle throttle positions. This test revealed the reverse idle r. p. m. to be from 300 to 500 higher than forward idle r. p. m. on all engines.

The captain and first officer stated that forward thrust was experienced when the throttles were moved past the detent into the reverse quadrant. Forward thrust is obtained when the throttles are moved into the reverse quadrant if the reversing control circuit breakers are "out" at the start of the throttle movement and remain "out" while the throttles are in the reverse range.

Three accelerated stop-runs were made in which the aircraft speed reached was 70-80 knots. During the first run normal brakes were used with the anti-skid feature turned off; the second run was with the antiskid on; the third run used propeller reversing only. In all three runs normal braking and deceleration was obtained.

On August 20 the aircraft was ferried to the Northwest Overhaul Base, St. Paul, Minnesota. Thorough checks were then made on the electrical systems and propeller domes and no malfunctioning was found.

The reversing control circuit breakers' being in the "out" position does not prevent the moving of the throttles back into the reverse quadrant and the increase of engine power in that position, but it does deactivate the propeller control circuits associated with reversing. Thus the propeller blades would remain in forward pitch producing forward thrust. When the oleo relay circuit breaker is "out" a throttle-locking solenoid prevents the throttles from going rearward past the throttle detent.

The Northwest Airlines Supervisor of Flight Engineers testified that this aircraft had been used the day of the accident for a captain's proficiency check and that he acted as flight engineer on that flight. He further testified that during the landing roll of the last flight, one or more of the engines started to die. As a corrective action one, and possibly both, of the propeller reversing control circuit breakers had been pulled and were in this position (off) when he left the aircraft a short time before the crew of Flight 410 took over.

It was explained that a number of incidents had been experienced wherein propeller blades moved to the feathered position when coming out of reverse on landing, due to a malfunction in the signal circuit.

Such an increase in blade angle is accompanied by an increase in propeller load that tends to stall the engine. Meanwhile, the auxiliary pump motor temperature increases and the motor will burn out if electrical power is not removed. Pulling out the appropriate circuit breaker results in shutting off the pump which in turn permits the propeller blades to move toward low pitch and the engine to regain normal idle speed.

The flight engineer of Flight 410 testified that he had made a thorough preflight inspection of this aircraft at Minneapolis, including checking the reversing control circuit breakers for "in" position. However, he could not

recall whether the check was made by actually touching the breakers or visually. He further testified that he thought it would be possible to overlook a circuit breaker position in a visual check.

The "checklist and procedures" section of Northwest Airlines Manual - Flight Operation - Boeing 377, lists the items to be checked by each crew member during all procedures from "Before start" to "After landing" and "Parking." The manual does not call for a mandatory propeller reversing check for preflight on domestic operations. The flight engineer ground check lists "Overhead circuit breakers - checked."

In the amplified flight engineer's ground check are listed items to be checked on originating aircraft. On page 10 in the "Aft Cockpit Area" paragraph this item (7) appears: "Overhead circuit breakers - CHECKED (a) all circuit breakers IN or ON."

There are no items covering a check of the circuit breakers on the overhead panel of the cockpit area during "Descent procedure," "Approach cockpit check," or "Landing cockpit check."

The manual does not specify how (i. e. visually or by touch) the circuit breakers are to be checked.

As a result of the subject accident Northwest Airlines took action on September 6, 1955, to incorporate in its flight operation manual a check of overhead panel circuit breaker position prior to landing. In addition, instructions were issued to flight instructor and check personnel to place emphasis during periodic training and check flights on the proper checking of circuit breakers.

Analysis

The severely scuffed condition of the main landing gear tires, observed after the accident, proves that the normal and emergency brake systems had effectively stopped wheel rotation and the marks found on the runway indicate that brakes were used during the latter part of the landing roll. The accelerated stop-run tests conducted at Chicago Midway Airport subsequent to the accident showed that the brake system of the aircraft was in normal operating condition and that by using these brakes alone the aircraft could be stopped in the required distance. It would require approximately 20 seconds to travel the 3,000 feet of runway between the touchdown and the first braking marks if a speed of somewhat less than the touchdown speed of 95 knots was maintained. During this short interval normal brakes were used while preparing to go into reversing, the throttles were moved in and out of the reverse quadrant, and the antiskid device was taken off. The sudden surprise of being confronted with lack of propeller reversing and the ensuing cockpit activities undoubtedly were the factors which determined where the emergency brakes were applied.

The captain testified that he applied emergency brakes when halfway down the runway or approximately 1,600 feet from the point of touchdown. Since no evidence of braking of the aircraft was found in this area it appears that the friction coefficient of the runway surface was considerably less during approximately 1,400 feet of the landing roll than it was where the first braking marks were observed. It was early in the afternoon of a warm day

(85°) and the temperature may have induced some slipperiness on the surface of the asphalt runway where the crushed rock screenings were worn away. However, aircraft landing just before and just after the accident did not report such a condition.

Although the crew stated there was no application of power during the entire landing roll, a feeling of acceleration occurred when the throttles were moved into the reverse quadrant. The propellers remained in forward pitch in this instance and engine r. p. m. increases appreciably when throttles are moved to the reverse idle position.

Thorough examination and tests of the propeller and electrical systems showed that these systems were functioning in a normal manner. Air carrier employees on Chicago Midway Airport and tower controllers testified that it is standard practice for operators of Boeing 377 aircraft to use propeller reversing on all landings at Chicago Midway Airport. This is the practice even though the lengths of the NW-SE and NE-SW runways, which are always used for this type aircraft, are in excess of the criteria specified for braked stopping in the flight manual for B-377 aircraft. Captain Stone testified that he fully intended to use reversing on the subject landing.

Since the propeller reversing circuit breakers were found in the "out" position and as this can be the only reason why propeller reversing could not be effected in this instance, it is apparent that they were not thoroughly checked during the preflight check at Minneapolis or the prelanding check at Chicago.

The Board concludes that the "out" position of the reversing control circuit breakers was the only reason to account for the captain's inability to obtain reversing when the throttles were moved into the reverse quadrant.

Findings

On the basis of all available evidence the Board finds that:

1. The company, the aircraft, and the crew were currently certificated.
2. The aircraft was properly loaded with respect to gross weight and location of its center of gravity.
3. The flight between Minneapolis and Chicago was routine and in good weather.
4. The structure, powerplants, propellers, brakes, and electrical systems were found to be capable of normal operation.
5. The propellers did not reverse when the throttles were moved into the reversing quadrant.
6. After the accident the circuit breakers of the propeller reversing system were found in the "out" or inoperative position which precluded propeller reversing.

7. Evidence indicates that the propeller reversing circuit breakers were pulled during a prior flight at Minneapolis and were not reset prior to the accident.

Probable Cause

The Board determines that the probable cause of the accident was the inability of the pilot to stop the aircraft by means of conventional braking and the unavailability of propeller reversing due to the improper position of the reversing circuit breakers.

BY THE CIVIL AERONAUTICS BOARD:

/s/ ROSS RIZLEY

/s/ JOSEPH P. ADAMS

/s/ CHAN GURNEY

/s/ HARMAR D. DENNY

S U P P L E M E N T A L D A T A

Special Investigation

The Civil Aeronautics Board was notified of the accident at approximately 1315, August 5, 1955. An investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A special investigation was ordered by the Board and depositions were taken at Chicago, Illinois, on September 15 - 16, 1955, at Minneapolis, Minnesota, on September 19, 1955, and at Washington, D. C., on September 22, 1955.

Air Carrier

Northwest Airlines, Inc., is incorporated in the State of Minnesota and maintains its principal place of business at Minneapolis, Minnesota. The company possesses a certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration which authorize the carriage of persons, property, and mail over the route described in this report.

Flight Personnel

Captain George A. Stone, age 39, was employed by Northwest Airlines on August 28, 1942. He holds a valid airman certificate with an air transport rating and type ratings for DC-3, DC-4, M-202, C-46, DC-6, and B-377 aircraft. Captain Stone had, according to company records, 11,993 hours of logged flight time, of which 65 hours were acquired in Boeing 377 aircraft. He received his Boeing 377 checkout on July 14, 1955. His last first-class physical examination was successfully passed, no limitations, on February 24, 1955.

First Officer Ralph T. Gray, age 32, was employed by Northwest Airlines on February 6, 1946, and was assigned to copilot duties June 23, 1948. He holds a valid airman certificate with an air transport rating and commercial pilot, multi-engine land and instrument ratings. First Officer Gray had, according to company records, 7,131 hours of logged flight time of which 1,231 were acquired in Boeing 377 aircraft. His last first-class physical examination was successfully passed, no limitations, on April 18, 1955.

Flight Engineer Harry L. Camm, age 31, was employed by Northwest Airlines on December 17, 1948. He holds a valid Flight Engineer certificate with rating on Boeing 377 aircraft. He completed flight engineering training on October 4, 1954, and February 18, 1955. His total logged time as flight engineer was 220 hours on Boeing 377 aircraft. He successfully passed a second-class physical examination, no limitations, on August 13, 1954.

Stewardess L. J. Holden, age 22, was employed by Northwest Airlines on July 21, 1955. Stewardess H. L. Kennedy, age 25, was employed on June 8, 1955.

Flight Service Attendants M. D. Leahy, age 23, and E. P. Williams, age 22, were both employed by Northwest Airlines on April 15, 1955.

The Aircraft

N 74601, a Boeing 377, serial number 15947, was owned by Northwest Airlines, Inc. Its manufacture was completed on February 18, 1949, and the airframe had accumulated 16,861 flight hours at the time of the accident. The Airframe had 1,374 hours since its last major inspection. Powerplants were four Pratt and Whitney R-4360-B6 engines and four Hamilton Standard model 24260-43 propellers. Time since overhaul on the engines varied between 24 hours and 539 hours. Time on the propellers since overhaul varied between 483 hours and 1,155 hours.

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